
VDOT
Virginia Department of Transportation

VDOT RESILIENCE EFFORTS

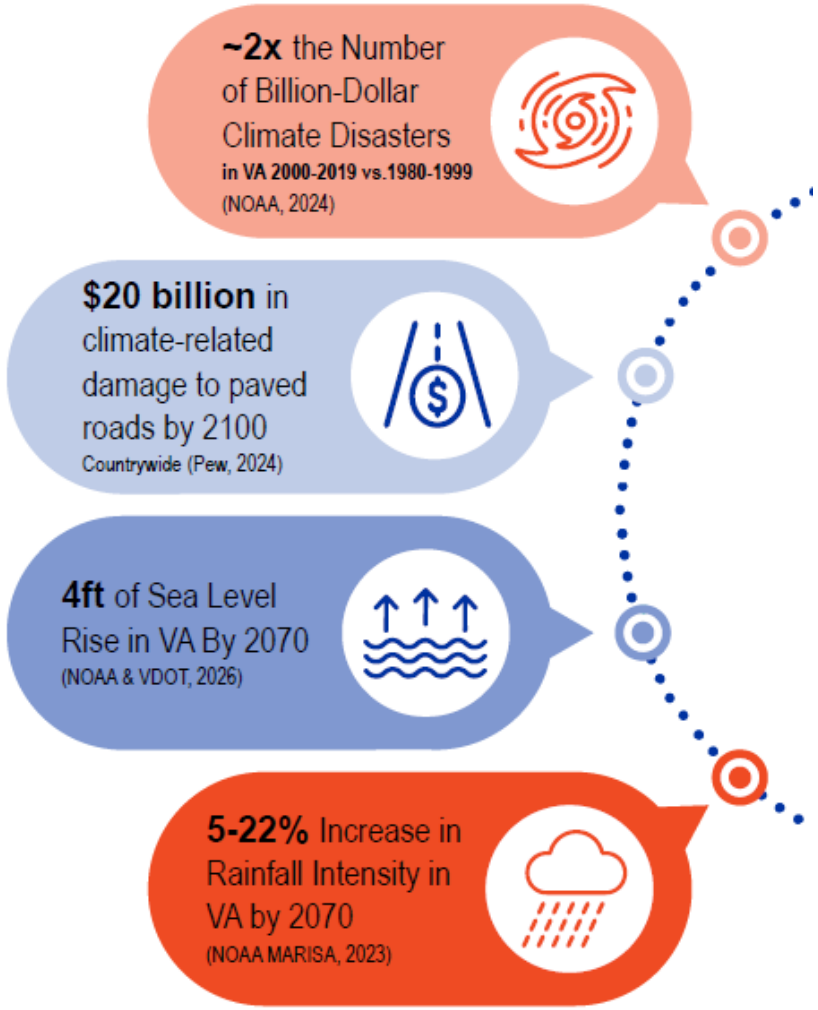
Chris Swanson, Environmental Division Director

09/15/2026

Need for Resilience

- Shifting environmental conditions are increasing the impacts of natural hazards on our assets – on top of ongoing Maintenance and Operations challenges
- In 2021 CTB adopted three Strategic Actions directing data collection, policies, and collaboration to mitigate flooding risks
- VDOT released Resilience Plan in 2022 building on these actions
- Today's presentation provides an overview of efforts since 2022
- Follow up presentation will address cost implications of resilience

Urgent Need for Resilience



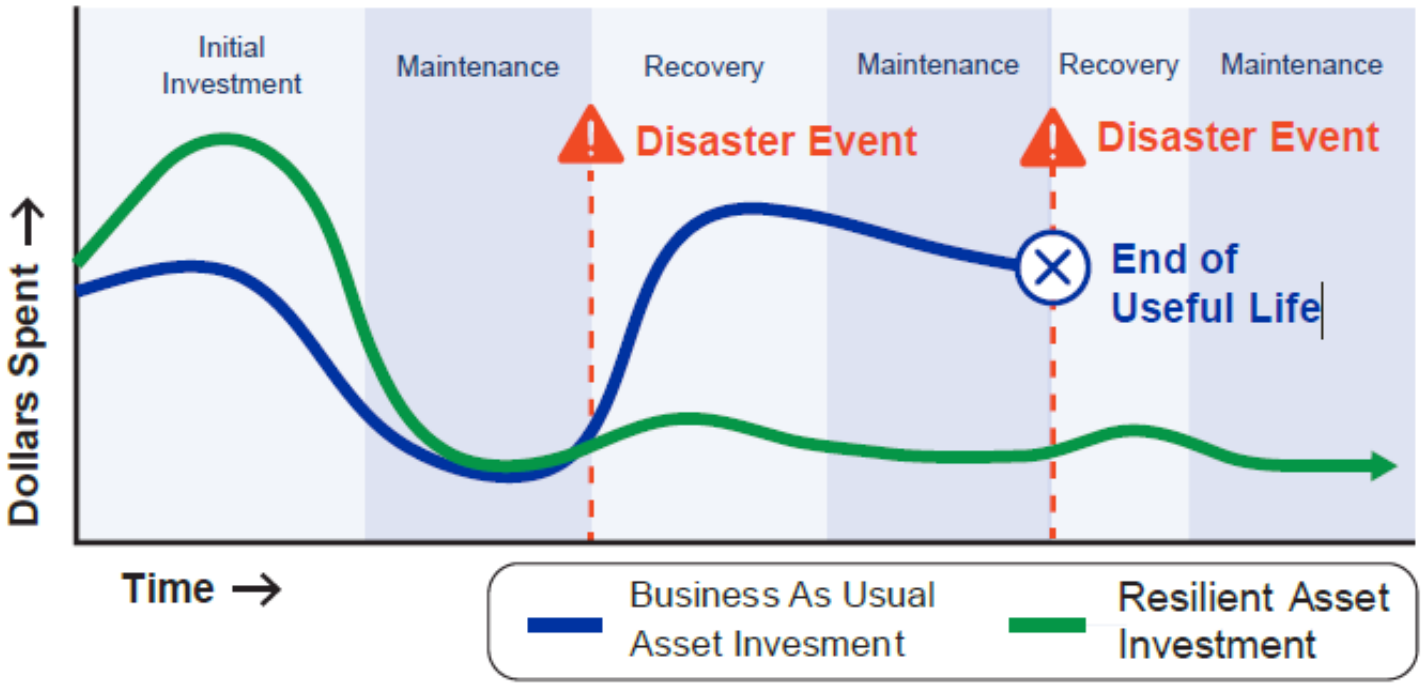
- Shifting environmental conditions are placing greater stress on transportation assets and network
- Hurricane Helene highlighted the need for resilience investments
  - 414 road and 99 structures closed
  - Over 12 months of repair
- Norfolk experienced over 6 inches of rain in 2 hours on August 6th, 2026 that coincided with high tide
  - Sea level rise and high tides can reduce the capacity of the storm sewer system by up to 80% before a rain event
  - Significant roadway flooding and submerged vehicles

Why Invest in Resilience?

Investments support proactive preservation approach, leading to:

- Stronger infrastructure that can withstand impacts and extend its useful life
- Sustained operations with lower maintenance costs
- Expedited recovery after disaster events
- Increased public safety and confidence

Investing In Resilience Today



Every $1 Invested in Resilience Results in up to $11 of Damages Avoided (NIBS, 2019)

Virginia Resilience Drivers

Executive Orders (EO)

- EO 24 (2018) – Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards
- EO 45 (2019) – Floodplain Management Requirements and Planning Standards for State Agencies, Institutions, and Property

Legislation

- Chapter 51 (2021) – requires the Commonwealth Transportation Board (CTB) to consider resilience when adopting the Statewide Transportation Plan and, when evaluating projects for SMART SCALE, determine whether a project has been designed to be resilient.
- Chapter 52 (2021) – requires that the Commissioner of Highways incorporate resiliency into the design standards for new construction projects.

VDOT Resilience Drivers

VTrans Strategic Actions (2021):

1. Collect data (e.g., right-of-way mapping, precipitation, roadway elevation, etc.) to accurately assess flooding risks for state- and locally-maintained roadways that can be used to identify funding needs and prioritize investment.
2. Develop policies, based on robust data collection and analysis, to ensure flooding risks are reflected in transportation asset life cycle and/or transportation project planning processes.
3. Collaborate with state/regional agencies to systematically identify solutions that facilitate consistent and systematic prioritization and support the allocation of state resources to address flooding risks.

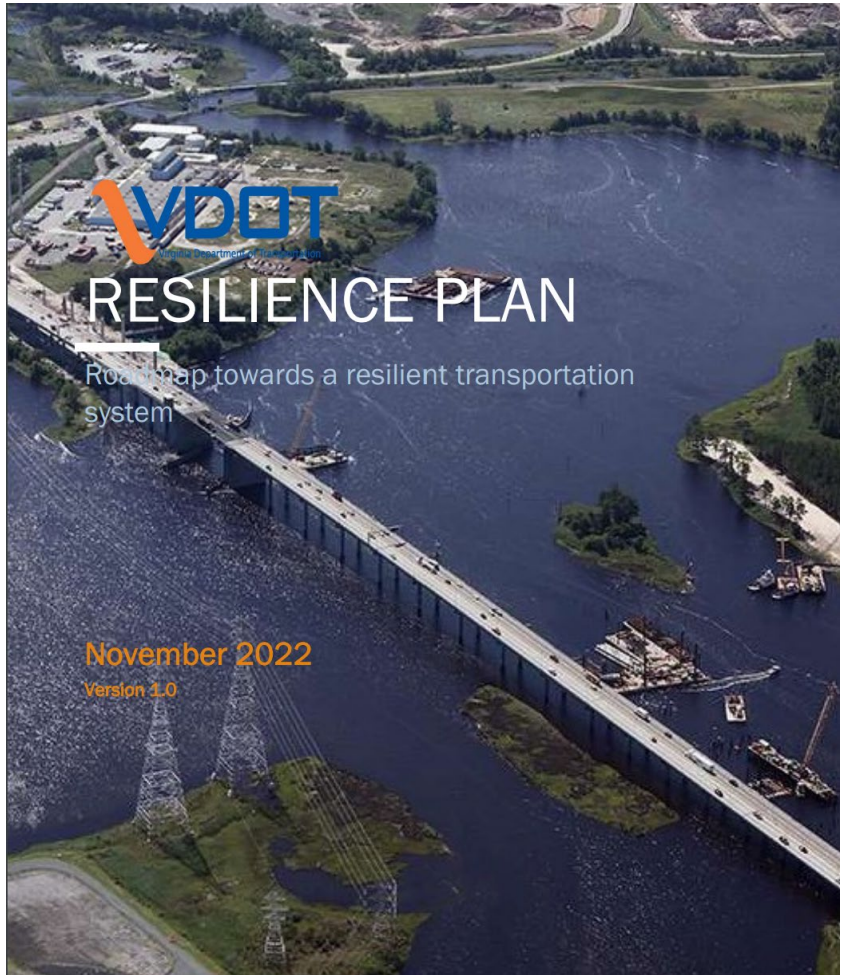
VDOT developed the Resilience Plan to guide the implementation of these Strategic Actions

VDOT Resilience Definition

Transportation Resilience is the capability of a transportation project or strategy to anticipate, prepare for, respond to, or recover from significant multi hazard threats with minimum damage and disruption to the transportation network, while preserving and incorporating natural and built infrastructure that helps to mitigate these threats.



Incorporate resilience into existing business practices



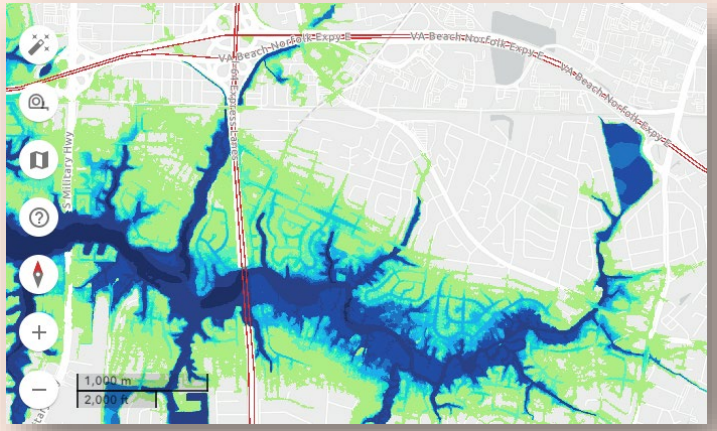
VDOT Resilience Plan Layout: Objectives & Strategies

1. Data Driven Decisions	• Authoritative Datasets • Data and Research Gaps
2. Stakeholder Engagement	• Coordination with Federal, State, MPO, Local Initiatives
3. Identify Vulnerable Infrastructure	• Visualization Tool (Asset and Network Vulnerability and Risk Assessment) • Inform focus areas, projects
4. Resilience Practices	• Adaptive Design Criteria (Hydraulics, Materials, Structure and Bridge) • Other Physical Enhancement Practices • Natural and Nature-based Solutions • Operational, Maintenance, and Emergency Management Practices • Administrative and Policy Practices
5. Feasibility and Cost Effectiveness Analyses	• Benefit Cost Analysis (BCA) Tool
6. Funding Opportunities	• PROTECT • Other Funding Opportunities

VDOT Resilience Tools

1 Identify Highly Vulnerable Infrastructure

Identify if project or activity includes vulnerable assets



Visualization Tool

2 Options to Address/Mitigate Vulnerability

Identify design/construction, traffic operations, maintenance, and emergency management practices

Construction	Adaptive Design Criteria (Structures & Bridge, Hydraulics, Materials)
	Natural and Nature Based Solutions
	Other Physical Enhancement Practices
Traffic Operations	Power Redundancy
	Transportation Network Redundancy
	Equipment Resilient Design/Installation
Maintenance	Pre-Storm Best Practices
	Upsizing vs. In-Kind Replacement
OSSEM	Flood Forecasting during weather events
	Enhancement to Processes for Identifying Mitigation Opportunities

Resilience Practices Toolbox

3 Evaluate Cost Effectiveness of Resilience Options

Evaluate if benefits of reduced replacement, maintenance, closure, and traffic outweigh costs

STEP 1: What is at-risk?				
1.1	**Hazard you are looking to mitigate**	Coastal Flooding		
	Hazard Exposure Score (Visualization Tool)	2.31-2.45		
1.2	**Size of the relevant at-risk asset(s)**	*Road:*	20	MI
	e.g., 20 lane miles of road are at-risk due to the	*Bridge:*	0	SQF
	selected hazard at this site	*Culvert:*	0	LF
STEP 2: What resilience practice(s) are you proposing to mitigate this risk?				
2.1	**Primary resilience practice (RP 1)**	Raise Roadway (by 2 feet)		
2.2	**Details of RP 1**	*Design Size:*	1000	CYD
		Unit Cost:	$922.50	pe
		Cost of RP 1:	$922,500.00	

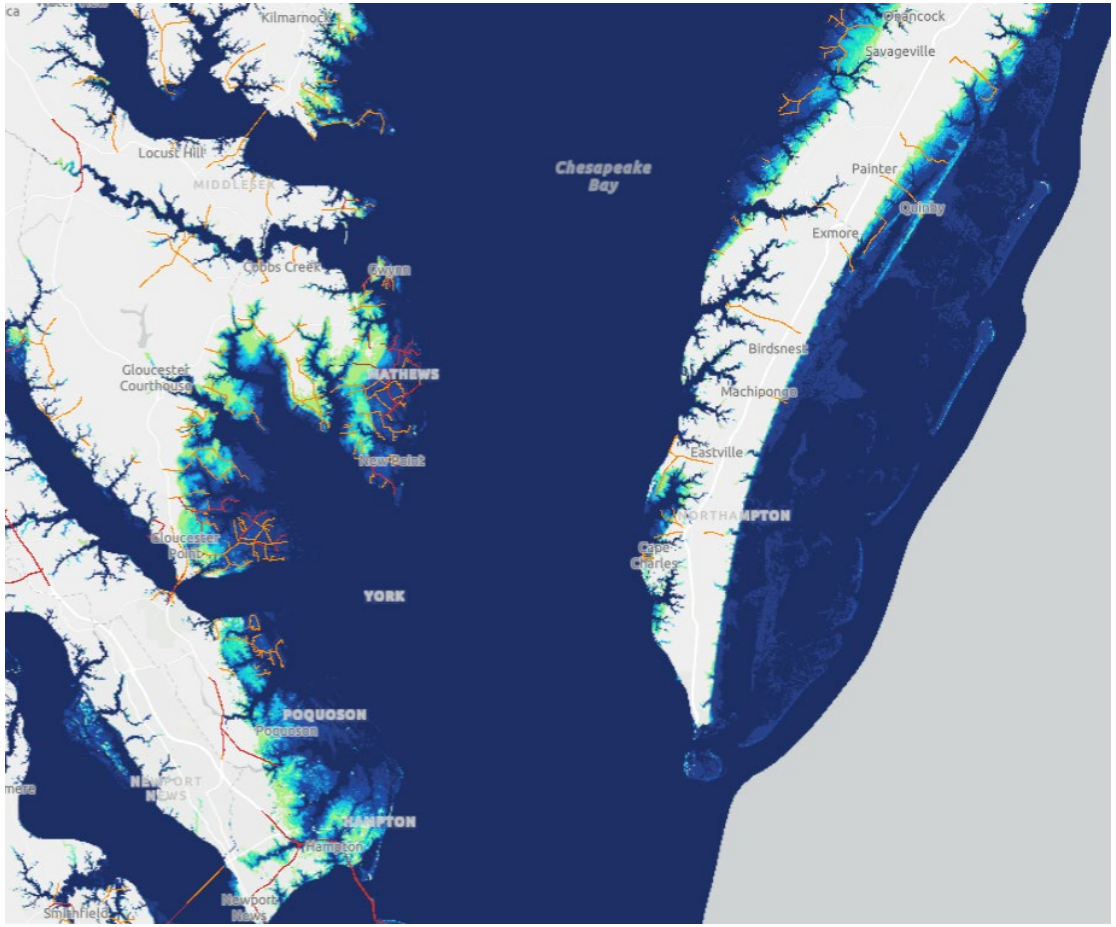
Benefit Cost Analysis Tool

**Tools are in development and have not yet been released*

1 VDOT Identification of Highly Vulnerable Infrastructure

Goal: Identify assets statewide that are vulnerable to coastal flooding, inland flooding, and landslides

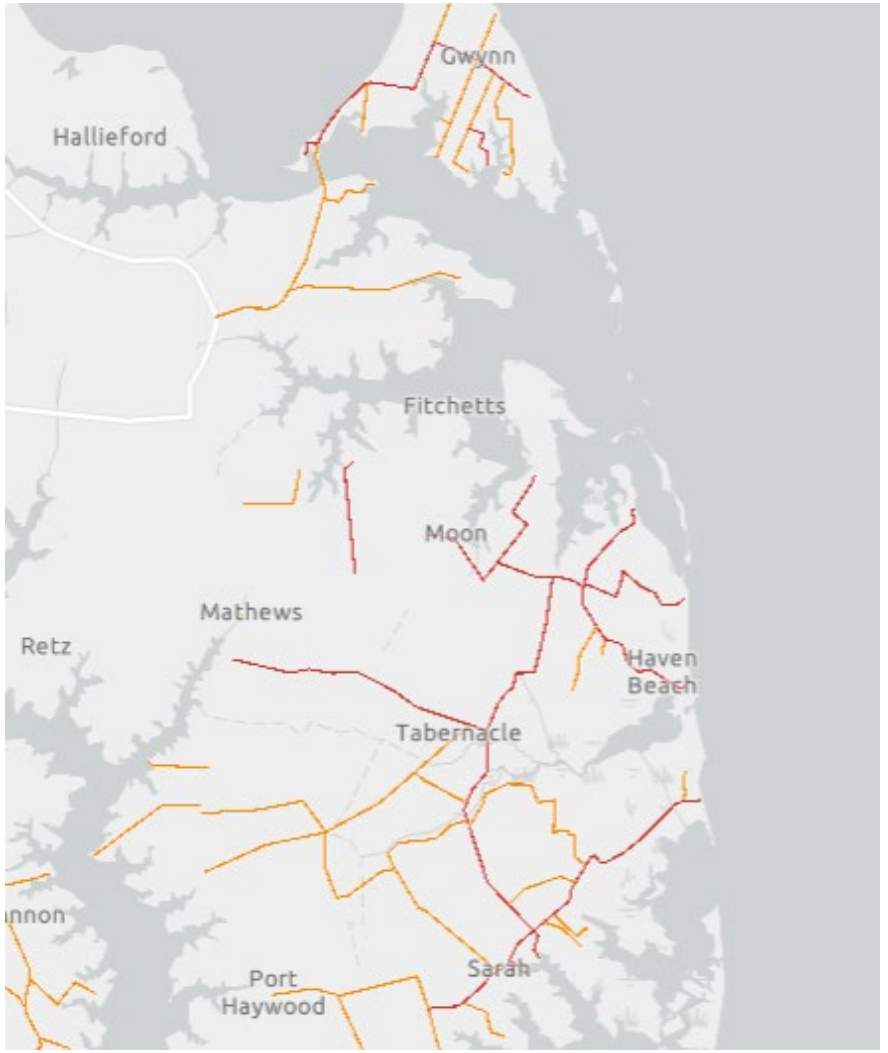
- Focused on High Vulnerability assets
- Vulnerability scoring:
  - **Exposure** – Asset directly subject to natural hazard(s). E.g., coastal flooding
  - **Sensitivity** – How asset is affected by natural hazard(s). E.g., pavement condition
  - **Adaptive Capacity/Importance** – Ability to mitigate disruption to the network from natural hazard(s). E.g., Average Annual Daily Traffic



1 VDOT Identification of Highly Vulnerable Infrastructure

The Vulnerabilty Tool is a model

- Projects must be further evaluated for site specific conditions – e.g. elevation, slope data
- If the asset is confirmed to be vulnerable, further evaluation will be warranted



2 VDOT Resilience Practices Toolbox

Goal: Provide a suite of vetted resilience practices for potential inclusion in projects to mitigate for coastal flooding, inland flooding, and landslides

Practice	Primary Division(s)	Resilience Purpose/Developed Tools
Adaptive Design Criteria	Structures & Bridge (S&B)	Structure and Bridge Chapter 33 (2020): Enhance scour protection, increase superstructure elevation, include corrosion resistant materials
	Location & Design (L&D)	Drainage Manual Chapter 18 (Draft): Enhance hydraulic design to incorporate increase in precipitation and sea level rise
	Materials	Material Memorandum of Instruction – Geotechnical, Pavement (Draft): Enhanced pavement and geotechnical design to incorporate increase saturation due to increased precipitation and flooding
Other Physical Enhancement Practices	Environmental/ L&D	VDOT OPEP Reference Materials Report (Draft) : Coastal (Breakwaters, Groins), Riverine (Riverine Vanes, Flood Diversion Berms), and Slope and Bank Stability
Natural and Nature-Based Solutions	Environmental	Living Shoreline NNBS Pilot Simonson Rd. NNBS Reference Manual (Draft) NNBS Prioritization Tool (help select among sites) NNBS BCA Tool (help select among NNBS scenarios)

3 VDOT Benefit Cost Analysis Tool

Goal: Compare benefit cost ratios (BCRs) of proposed resilience practices to mitigate for hazard vulnerabilities within a given project

- Use the BCR to inform selection of cost beneficial resilience alternative
- BCR estimates incremental benefits and incremental costs of adding resilience to a project

$$\text{Benefit/Cost Ratio} = \frac{\Delta A+\Delta B+\Delta C+\Delta D+\Delta E}{\Delta \$}$$

Benefits:

Δ A = Annual Replacement Benefit

Δ B = Annual Routine Maintenance Benefit

Δ C = Annual Emergency Maintenance/Closure Benefit

Δ D = Annual Traffic Benefit

Δ E = Annual Ecosystem Services Benefit (only for NBS)

Costs:

Δ\$ = Projected Annualized Cost of Resilience (includes construction and O&M)

Next Steps: Estimating the Cost of Resilience

- SYIP is being screened against Highly Vulnerable Visualization Tool for projects (in final design/awarded/in construction) which include assets that are highly vulnerable to coastal flooding, inland flooding, and landslides. Initial screening resulted in 71 projects.
- Projects are being evaluated to estimate the total incremental cost of incorporating resilience practices.
- Come back to the Board in October to discuss results


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